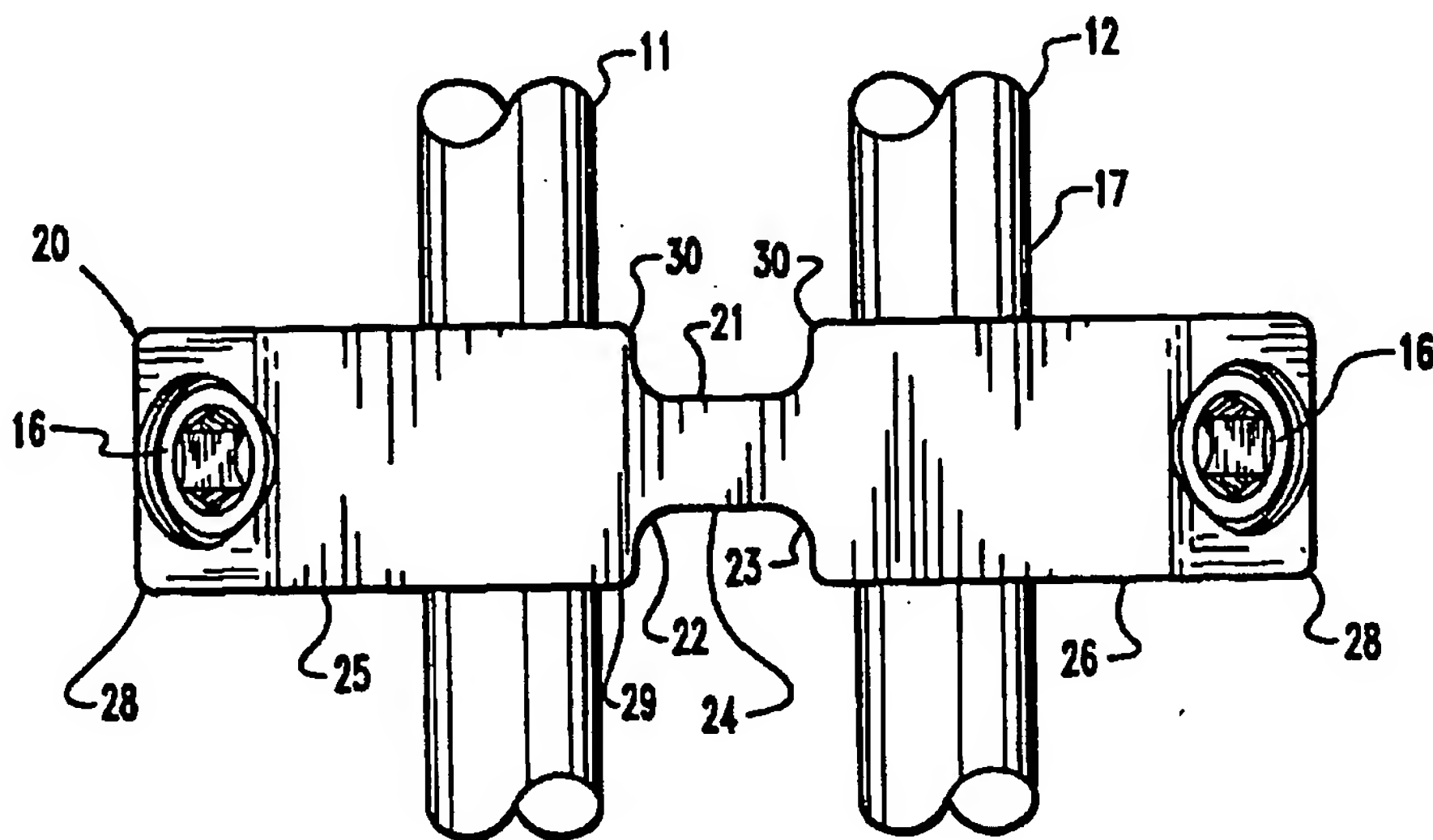




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(54) Title: DEVICE FOR LINKING ADJACENT RODS IN SPINAL INSTRUMENTATION



(57) Abstract

One embodiment of a spinal fixation system (10) including a pair of longitudinal members (11, 12) positionable adjacent the spine, means for engaging longitudinal members to the spine (13, 14), a pair of wedge members (16) each having a bearing surface (38) configured to bear on a longitudinal member (11, 12), and a connector (20) configured to span a distance between the longitudinal members (11, 12). The connector (20) includes a pair of engaging members (25, 26) each having a fixation surface (33) and a connecting surface (30), and a bridge member (21) attached to the connecting surfaces (30). The engaging members (25, 26) each define a thru-hole (35) for receiving one of the wedge members (16). The thru-holes (35) are aligned so that when one of the wedge members (16) is advanced through the thru-hole (35) the bearing surface (38) will bear on a corresponding longitudinal member (11, 12) to force the longitudinal member (11, 12) into contact with the fixation surface (33) and engage the longitudinal member (11, 12) to the connector (20).

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DEVICE FOR LINKING ADJACENT RODS
IN SPINAL INSTRUMENTATION

FIELD OF THE INVENTION

5 The present invention broadly concerns devices for use in
spinal implant systems, particularly those using spinal rods
contoured for connection at various locations along the
length of the spinal column. More specifically, the
invention concerns an apparatus for linking adjacent spinal
rods in a top-loading and top-tightening fashion. This
10 invention is particularly useful with methods and devices for
posterior fixation of the spine.

BACKGROUND OF THE INVENTION

15 Several techniques and systems have been developed for
use in correcting and stabilizing spinal curvatures, and for
facilitating spinal fusion in the case of spinal disorders or
degenerative conditions. Typically, a pair of bendable rods
are longitudinally disposed adjacent the vertebral column and
are fixed to various vertebrae along the length of the spine
by way of a number of fixation elements, such as hooks and
20 screws.

25 Numerous spinal rod systems have been developed which
provide transverse connectors for linking the adjacent spinal
rods across the spinal midline to provide a rigid and stable
construct. Most of these systems present one or more
difficulties for spinal surgeons. Many of the devices are
high profile which increases soft tissue trauma and surgical
complications. Furthermore, in many of these prior systems
the attachment mechanisms must be preloaded on the spinal

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rods which can require significant pre-operative planning and which virtually eliminates the opportunity to add connectors in situ.

One transverse connector system is the TSRH®
5 CROSSLINK® of Danek Medical, Inc. The TSRH® CROSSLINK® utilizes a three point shear clamp mechanism which restricts motion between the rods in all directions, and particularly resists axial forces between rods and torsional moments about the axis of the rods. A quadrilateral construct is formed by
10 laterally connecting the rods across the sagittal plane with rigid plates. The lateral connection reduces the loss of correction that can occur over time.

Rigid transverse connections between spinal rods are beneficial because they restrict rod migration and increase
15 construct stiffness. In many cases involving multi-level fusion of the spine, these features are essential while solid bone fusion is accomplished. In the post-operative period before fusion occurs, a significant amount of motion can occur between the rods, wires and hooks, which can, for
20 example, allow a scoliotic correction to decrease or the pelvis to de-rotate toward its previous, deformed position. By providing a rigid transverse connection between two spinal rods, the loss of correction can be reduced and a stiffer construct can be created which may enhance the promotion of a
25 solid fusion. While the TSRH® CROSSLINK® provides an excellent construct, a need has remained for low profile devices which link adjacent spinal rods in a top-loading and top-tightening fashion with a minimum of components and steps.

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SUMMARY OF THE INVENTION

In accordance with one aspect of the invention, a connector is provided for linking adjacent longitudinal members, such as spinal rods, engaged to a spine. The apparatus includes a bridge member sized to span at least a portion of the distance between the spinal rods. A pair of engaging members are connected to the bridge member, each including a receptacle configured to receive a longitudinal member when the connector is disposed over the adjacent rods. The engaging members also include a fixation surface adjacent to the receptacle and configured for engaging a longitudinal member, and a thru-hole defined in the engaging member adjacent to the receptacle for receiving a wedge member. The thru-hole intersects the receptacle and is aligned at an angle such that as the wedge member is advanced through the thru-hole, the wedge member will bear against a rod initially disposed in the receptacle and push the rod against the fixation surface to engage the connector to the rod.

In one specific embodiment of the invention, the engaging members include elongated connecting portion which are received by a bore in the bridge member. The bridge member also includes a pair of engaging surfaces adjacent to and contiguous with a respective one of the bores for engaging a connecting portion. A second thru-hole defined in the bridge member intersects each one of the bores and is aligned at an angle such that as a wedge member is advanced through the second thru-hole, the wedge member will bear against the connecting portions and push each one against a corresponding one of the engaging surfaces.

In another specific embodiment, the bridge member defines a slot for receiving one of the connecting portions and a first fastener bore which intersects the slot. The connecting portion also defines a second fastener bore which

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is alignable with the first fastener bore of the bridge member when the connecting portion is inserted into the slot.

5 In some embodiments of this invention, the fixation surface includes a circular concavity which has a smaller radius than the radius of the longitudinal member. This provides three points of contact on each of the longitudinal members which restricts motion between the rods in all directions.

10 One object of the invention is to provide an apparatus for use in laterally connecting longitudinal members implanted adjacent a patient's vertebral column. Another object of this invention is to provide an apparatus which restricts rod migration and increases overall construct
15 rigidity.

One advantage of this invention is that it provides fixation assemblies that can be top loaded, or implanted over spinal rods after the spinal rods have been engaged to the spinal column. A further benefit is achieved by
20 top-tightening aspects of the invention.

Another benefit of this invention is that it provides three points of contact on the spinal rod which restricts rod migration and increases overall construct rigidity.

25 Other objects and further benefits of the present invention will become apparent to persons of ordinary skill in the art from the following written description and accompanying figures.

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BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top elevational view of a spinal fixation system engaged to a spine according to one aspect of this invention.

5 FIG. 2 is a top elevational view of a transverse connector engaged to spinal rods wherein the engaging members are disposed medially and the thru-holes are disposed laterally on the connector.

10 FIG. 3 is a cross-section of the transverse connector of FIG. 2.

FIG. 4 is a cross-sectional view of the transverse connector of FIG. 2 which is top loaded over two spinal rods.

FIG. 5 is a cross-sectional view of the transverse connector of FIG. 2 engaged to two spinal rods.

15 FIG. 6 is a side elevational view of a set screw.

FIG. 7 is a top elevational view of a set screw.

20 FIG. 8 is a top elevational view of a transverse connector similar to FIG. 1 except that the engaging members are disposed laterally and the thru-holes are disposed medially on the connector.

FIG. 9 is a side elevational view of the transverse connector of FIG. 8.

FIG. 10 is a side elevational view of an alternative embodiment of a transverse connector.

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FIG. 11 is a top elevational view of a closed transverse connector embodiment.

FIG. 12 is a side elevational view of the transverse connector of FIG. 11.

5 FIG. 13 is a top elevational view of an adjustable transverse connector.

FIG. 14 is a side elevational view of the transverse connector of FIG. 13.

10 FIG. 15 is a cross-sectional view of the connector of FIG. 13 taken along lines 15-15.

FIG. 16 is a top elevational view of another adjustable transverse connector.

FIG. 17 is a side elevational view of the bridge member of the transverse connector shown in FIG. 16.

15 FIG. 18 is a side elevational view of an alternative embodiment of the transverse connector having shortened connecting portions.

FIG. 19 is a perspective view of still another adjustable transverse connector according to this invention.

20 FIG. 20 is a side elevational view of the transverse connector shown in FIG. 19.

FIG. 21 is an exploded side view of the transverse connector of FIG. 19.

25 FIG. 22 is a perspective view of still another transverse connector of this invention.

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

The present invention is useful for posterior internal fixation of the spine which is indicated for correcting and stabilizing spinal curvatures and for facilitating spinal fusion in the case of spinal disorders or degenerative conditions. This invention provides a top-loaded, top-tightening, low profile posterior fixation system which requires minimal instrumentation yet provides a stable, rigid quadrilateral construct that restricts rod migration and increases overall construct rigidity.

A spinal fixation system 10 in accordance with one preferred embodiment of the present invention is depicted in FIGS. 1-3. The system 10 includes a pair of longitudinal members, preferably spinal rods, 11, 12 means for engaging the longitudinal members to the vertebral column, 13, 14, a pair of wedge members 16 and a connector 20 configured to span a distance between the rods 11, 12 when the rods 11, 12 are engaged to the spine.

As shown more clearly in FIGS. 2 and 3, the connector 20 includes a pair of engaging members 25, 26 each defining a fixation surface 33 at a corresponding first end 28 thereof. The connector 20 also includes a connecting surface 30 at a second end 29 of each engaging member 25, 26. A bridge

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member 21 includes a first end 22 and a second end 23 which are attached to the connecting surfaces 30 of each of the rod engaging members 25, 26. The bridge member 21 preferably includes a reduced width and depth portion 24 to avoid the laminae and spinous process remnant during the surgical procedure. The reduced portion 24 also provides means for contouring or bending the connector 20 as needed to conform to the spinal anatomy of the patient.

Each of the engaging members 25, 26 further defines a receptacle 36 for receiving a spinal rod therein and a first thru-hole 35 for receiving a wedge member 16. The thru-holes 35 intersect the corresponding receptacles 36 and are aligned so that when a wedge member 16 is advanced through the thru-hole 35, the wedge member 16 bears on a corresponding rod 11, 12 within a receptacle 36 to force the rod 11, 12 into contact with an opposite fixation surface 33 to engage the rod to the connector. In one specific embodiment, the engaging members 25, 26 are integrally attached to the bridge member 21.

One advantage of this invention is that it provides connectors that can be top loaded, or implanted over spinal rods after the spinal rods have been engaged to the vertebrae. Top-loading is advantageous because it reduces the required size of the surgical opening and resulting trauma to the patient, and because it greatly simplifies the surgical implantation. Top-loading also provides a mechanical advantage during implantation of the system in that the connector 20 can be easily placed over adjacent rods 11, 12 and then the rods 11, 12 can be locked laterally relative to each other by tightening the wedge members 16.

Referring to FIGS. 3, 4 and 5, the connector 20 can be disposed or loaded over longitudinal members or rods 11, 12 which have been previously engaged to the spine such that the rods 11, 12 are received into the receptacle 36 of the connector 20. Then, as a wedge member 16 is advanced through

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a thru-hole 35, the wedge member 16 pushes the rod 11 against the fixation surface 33. Preferably, the fixation surface 33 is a circular concavity which has a smaller radius than the radius of the rod 11, 12. This configuration provides three
5 points of contact a, b, c on the longitudinal members 11, 12 as shown in FIG. 5. Two points of contact a and b are provided by the fixation surface 33, and the third point of contact c is provided by bearing surface 38 on the wedge member 16.

10 As shown more clearly in FIGS. 6 and 7, the wedge member 16 is preferably a set screw 37 which has a bearing surface 38 and an internal hex 39 to accept a conventional driving tool. Most preferably, the head 34 of the wedge member 16 or set screw 37 is configured to rest entirely within the
15 thru-hole 35. In this manner, the set screw 37 can be situated so that it does not extend above the upper surface 31 of the connector 20 when the set screw 37 is fully advanced in the thru-hole 35 and bearing against a rod 12 as shown in FIG. 5. In the case of a threaded set screw 37, the
20 thru-holes 35 carry corresponding female threads. Preferably, bearing surface 38 is shaped to conform to an outer surface 17 of a rod 11, 12. The outer surface 17 of the rod 11, 12 is typically circular, but can be of any suitable shape. The bearing surface 38 is preferably a
25 tapered tip 42.

Referring to FIGS. 2 through 5, the bridge members defines an axis B between the first end 22 and the second end 23 of the bridge member 21. The thru-holes 35 are preferably oriented at an angle A of less than 90° relative to the axis
30 B of the bridge member 21. Any angle which allows the wedge member 16 to bear against a rod 11, 12 in the receptacle 36 and push the rod 11, 12 against the fixation surface 33 so that the adjacent rods 11, 12 are retained in a desired special relationship are contemplated. Such angles include
35 but are not limited to angles of about 40° , 45° and 60° .

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Preferably the angle is established to preserve the top-tightening aspect of the invention, which can help reduce the size of the surgical site for implantation.

In the embodiments shown in FIGS. 1 through 5, the connector 20 includes thru-holes 35 which are disposed laterally on the connector, i.e., laterally outboard from the axis B. In this configuration the thru-holes 35, and therefore the wedge members 16, act toward the axis B. Alternatively, the first thru-holes 44 may be disposed medially on the connector 40, as shown in FIGS. 8 and 9. This embodiment is desirable when the span between the longitudinal members 11, 12 is sufficient to accommodate both wedge members 41. A transverse connector 20 which utilizes laterally disposed wedge members 16 such as depicted in FIGS. 1-5, can be used when the span between the longitudinal members 11 and 12 is smaller than about 1 1/8" (28mm). However, when appropriate, the medial connector embodiment 40 is desirable because it permits a smaller surgical site and allows easier access to the wedge members 41 with tools (not shown) for engaging the wedge member 41 during the surgical procedure.

Referring to FIG. 10, this invention also contemplates a C-clamp shaped connector 60. The C-clamp connector 60 also includes a bridge member 62 which spans between a pair of engaging members 67, 68. The bridge member 62 is connected to each of the engaging members 67, 68 at a first end 63 and a second end 64 of the bridge member 62. A pair of receptacles 70 on the connector 60 are configured to receive longitudinal members or rods 11, 12. A first thru-hole 75 is defined in each of the engaging members 67, 68. The thru-holes 75 intersect the corresponding receptacles 70 and are aligned at an angle such that as a wedge member 76 is advanced through the thru-hole 75, the wedge member 76 will bear against the longitudinal member 11, 12 and push the longitudinal member 11, 12 against a fixation surface 71

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adjacent to the corresponding receptacles 70 to engage the connector 60 to a longitudinal member 11, 12. Like the previous embodiments, the connector 60 can be loaded over a pair of spinal rods 11, 12, with the rods 11, 12 initially in contact with only the receptacles 70 or the underside of the connector 60. The connector can be manually shifted until the rods contact the fixation surfaces 72. Final engagement is accomplished by tightening the wedge members 76 against the rods.

10 Closed connector embodiments are also contemplated by this invention as shown in FIGS. 11 and 12. The closed connector 80 must be preloaded on the longitudinal members 11, 12 before the longitudinal members 11, 12 are engaged to a spinal column. The closed connector 80 includes a bridge member 81 attached to a pair of engaging members 82, 83. A pair of rod receptacles 87 are configured to receive a longitudinal member 11, 12. A first thru-hole 85 is defined in each engaging member 82, 83 for receiving a wedge member 16. As the wedge member 16 is advanced through the thru-hole 85, the wedge member 16 will bear against a longitudinal member 11, 12 in the receptacle 87 and push the longitudinal member 11, 12 against a fixation surface 88 to engage the connector 80 to the longitudinal member 11, 12. Preferably the fixation surface 88 is a circular concavity which has a smaller radius than the radius of the longitudinal member 11, 12, thus providing three points of contact as described above.

Another aspect of this invention provides means for adjusting the distance between the longitudinal members 11, 12 while still retaining the top-loaded and top-tightening aspects of the invention. FIGS. 13 and 14 show an adjustable transverse connector 90. The connector 90 includes a bridge member 91 having a first end 92, a second end 93 and engaging members 94, 95. The engaging members 94, 95 each include an engaging portion 96 which define thru-holes 99 and which are

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engageable to the longitudinal members 11, 12 as described above. Each engaging member 94, 95 also includes elongated connecting portions 97, 98 sized to span at least a portion of the distance between the adjacent longitudinal members or rods 11, 12. The bridge member 91 defines a pair of bores 101, each for receiving a corresponding one of the elongated connecting portions 97, 98. The bridge member also includes a pair of engaging surfaces 102 which are adjacent to and contiguous with a respective one of the bores 101 for engaging the corresponding connecting portions 97, 98, as shown in FIG. 15. A pair of second thru-holes 105 are defined in the bridge member 91 for receiving wedge members 106. A second thru-hole 105 intersects each of the bores 101 and is aligned at an angle such that as the wedge member 106 is advanced through the second thru-hole 105, the wedge member 106 will bear against the corresponding connecting portion 97, 98 and push each of the connecting portions 97, 98 against a corresponding one of the engaging surfaces 102. Preferably, the engaging surfaces 102 include a circular concavity which has a smaller radius than a radius of the bore 101 and of the circular connecting portions 97, 98.

One preferred embodiment of an adjustable transverse connector 120 which is similar to the embodiment shown in FIGS. 13-15 is shown in FIGS. 16 and 17. A single second thru-hole 135 defined in the bridge member 123 intersects both of the bores 130, 140 so that a single wedge member 129 engages both of the connecting portions 126, 127 as shown in FIGS. 16 and 17. According to this embodiment, a single wedge member 129 forces the connecting portions 126 and 127 laterally into the respective engaging surfaces 131, 141. Each engaging surface 131, 141 includes a concavity 142, 132 which has a centroid 138, 148. As shown in FIG. 17, a line α between the centroid 137 of a bore 130 and the centroid 138, of its corresponding adjacent concavity 132 and a line β between the centroid 147 of the other bore 140 and the

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centroid 148 of its corresponding adjacent concavity 142
diverge away from the second thru-hole 135. In this
configuration, as the wedge member 129 is advanced through
the second thru-hole 135 the connecting portions 126, 127 are
5 pushed away from the axis C of the second thru-hole 135. The
connecting portions 126, 127 are thus engaged to the
corresponding engaging surfaces 131, 141 with a single wedge
member 129.

In order to provide a broad range of connectors to
10 address a variety of spinal situations and vertebral levels,
connectors of various sizes are contemplated. For example,
the connector 110 shown in FIG. 18 provides shortened
connecting portions 112 connected to a bridge member 111.

The invention also includes a telescoping adjustable
15 transverse connector as shown in FIGS. 19 through 22. The
telescoping adjustable transverse connector 150 includes a
bridge member 152 connected to a first engaging member 155
and a second engaging member 162, each having a respective
first end 156, 163 and second end 158, 165. The engaging
20 members 155, 162 each include fixation portions 157, 164 at
the first end 156, 163. The fixation portions 157, 164 each
include receptacles 168, 169 and fixation surfaces 170, 171.
The receptacles 168, 169 are each intersected with a first
thru-hole 175. The fixation portions 157, 164 of the
25 connector 150 are engageable to longitudinal members in a top
loaded fashion in the manner described above.

The first engaging member 155 includes a first connecting
portion 159 at the second end 158. The second engaging
member 162 similarly includes a second connecting portion 166
30 at the second end 165. The bridge member 152 of the
connector 150 defines a slot for receiving the second
connecting portion 166. The first connecting portion 159 of
the first engaging member 155 is preferably integrally
attached to the bridge member 152. The bridge member 152
35 also defines a first fastener bore 177. The axis D of the

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first fastener bore 177 intersects the slot 153 for receiving a fastener 180. The second connecting portion 166 defines a second fastener bore 178. The second fastener bore 178 is alignable with the first fastener bore 177 when the second
5 connecting portion 166 is inserted in the slot 153. A fastener 180 is extendable through each of the first and second fastener bores 177, 178 to clamp the second connecting portion 166 to the bridge member 152. Any suitable fastener is contemplated, including but not limited to a hex head
10 screw 180 with an integral washer 181.

Preferably, the first fastener bore 177 of the bridge member 152 includes a recess 179 defined in an upper surface 154 of the connector 150 as shown in FIG. 22. The head 182 and washer 181 of the fastener 180 are sized to be received
15 within the recess 179 without extending above the upper surface 154 of the bridge member 152. This embodiment provides a low profile system. With this configuration it is contemplated that the fastener 180 can include a circular head with an internal hex recess to receive a driving tool.

Preferably, as shown in FIG. 19, the bridge member 152 also includes a number of first fastener bores 177 and the second connecting portion 166 is slidable within the slot 153 so that the second fastener bore 178 is alignable with each of the number of first fastener bores 177. This
20 configuration allows adjustability in the length of the connector 150. Preferably, the second connecting portion 166 includes an area of reduced width 167 for bending and contouring the connector 150.

The connectors and systems of this invention are preferably formed of medical grade stainless steel or similar high strength material. Other biocompatible materials are contemplated provided the material is strong enough to endure the high loads transmitted through the components. Specifically, the systems could be manufactured in 6Al4V
30 titanium or 316LVM stainless steel. The connectors can be
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provided in several different sizes as necessary to accommodate the spinal anatomy at the cervical, thoracic and lumbar segments of the spine.

5 While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiments have been shown and described and that all changes and modifications that come within the spirit of the
10 invention are desired to be protected.

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WHAT IS CLAIMED:

1. A connector for linking adjacent longitudinal members engaged to a spine, comprising:

5 a bridge member sized to span at least a portion of the distance between the adjacent longitudinal members, said bridge member having a first end and an opposite second end; and

10 a pair of engaging members each having a connecting portion connected to a respective one of said first and second ends of said bridge member, each of said engaging members including;

15 a receptacle configured to receive a longitudinal member when the connector is disposed over the adjacent longitudinal members, a fixation surface adjacent to said receptacle and configured for engaging a longitudinal member thereon, and

20 a first thru-hole defined in said engaging member adjacent to said receptacle for receiving a wedge member, said thru-hole intersecting said receptacle and aligned at an angle relative to said fixation surface such that as the wedge member is advanced through said thru-hole the wedge member will bear against a longitudinal member in said
25 receptacle and push the longitudinal member against said fixation surface to engage the connector to the longitudinal member, whereby adjacent longitudinal members in the engaging member at each end of said bridge member are retained in a desired spatial
30 relationship.

2. The connector of claim 1 wherein said fixation surface is a circular concavity.

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3. The connector of claim 2 wherein the longitudinal members are circular and have a radius and said fixation surface has a smaller radius than a radius of the longitudinal member.

5 4. The connector of claim 1 wherein said first thru-hole of each of said engaging members is disposed laterally on the connector.

10 5. The connector of claim 1 wherein said first thru-hole of each of said engaging members is disposed medially on the connector.

6. The connector of claim 1 wherein said bridge member defines an axis between said first end and said second end and said first thru-holes are oriented at an angle of less than 90° relative to said axis.

15 7. The connector of claim 6 wherein said thru-holes are oriented at an angle of less than about 60°.

8. The connector of claim 7 wherein said thru-holes are oriented at an angle of less than about 45°.

20 9. The connector of claim 8 wherein said thru-holes are oriented at an angle of about 10°.

10. The connector of claim 1 wherein said engaging members are integrally attached to said bridge member.

11. The connector of claim 1 wherein:
said connecting portions are elongated and sized to span

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at least a portion of the distance between the adjacent longitudinal members; and

said bridge member further comprises:

5 a pair of bores each for receiving a corresponding one of said connecting portions of said engaging members;

a pair of engaging surfaces each adjacent to and contiguous with a respective one of said pair of bores for engaging said connecting portion; and

10 a second thru-hole defined in said bridge member for receiving a wedge member, said second thru-hole intersecting each of said pair of bores and aligned at an angle relative to each of said pair of engaging surfaces such that as the wedge member is advanced through said second thru-hole the wedge member will bear against said
15 connecting portion and push each of said connecting portions against a corresponding one of said engaging surfaces.

20 12. The connector of claim 11 wherein said engaging surface is a concavity and said concavity has a smaller radius than a radius of said bore.

13. The connector of claim 12 wherein each of said concavities and bores have a centroid; and

25 a first line between said centroids of one of said concavities and said centroid of a corresponding adjacent bore and a second line between said centroid of the other of said concavities and said centroid of the corresponding adjacent bore each diverge away from said second thru-hole such that as the wedge member is advanced through said second thru-hole said connecting portions are pushed away from an
30 axis of said second thru-hole.

14. The connector of claim 1 wherein:

said connecting portions are elongated and sized to span

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at least a portion of the distance between the adjacent longitudinal members; and

said bridge member further comprises:

5 a pair of bores each for receiving a corresponding one of said connecting portions of said engaging members;

a pair of engaging surfaces each adjacent to and contiguous with a respective one of said pair of bores for engaging said connecting portion; and

10 a pair of second thru-holes defined in said bridge member each for receiving a wedge member, said second thru-holes intersecting a corresponding one of said pair of bores and aligned at an angle relative to each of said pair of engaging surfaces such that as the wedge member is advanced through one of said second thru-holes the
15 wedge member will bear against a corresponding one of said connecting portions and push said corresponding connecting portion against a corresponding one of said engaging surfaces.

20 15. The connector of claim 14 wherein said engaging surface is a concavity and said concavity has a smaller diameter than a diameter of said bore.

16. The connector of claim 1 wherein:
said bridge member defines a slot for receiving one of said connecting portions and a first fastener bore
25 intersecting said slot for receiving a fastener; and
said one of said connecting portions is insertable in said slot, said one of said connecting portions defining a second fastener bore, said second fastener bore alignable with said first fastener bore when said one of said
30 connecting portions is inserted in said slot.

17. The connector of claim 16, further comprising:
a fastener extendable through each of said first and

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second fastener bores and engageable therebetween to clamp said one of said connecting portions to said bridge member.

18. The connector of claim 17 wherein said bridge member includes a number of first fastener bores and said one of
5 said connector portions is slidable within said slot so said second fastener bore is alignable with each of said number of first fastener bores.

19. A spinal fixation system, comprising:
a pair of longitudinal members positionable adjacent
10 the spine;
means for engaging said longitudinal members to the spine;
a pair of wedge members, each of said wedge members having a bearing surface configured to bear on a
15 longitudinal member; and
a connector configured to span a distance between said longitudinal members when said longitudinal members are engaged to the spine, said connector including;
a pair of engaging members, said engaging
20 members each defining a fixation surface at a first end and including a connecting surface at a second end, and
a bridge member attached to the connecting surfaces of each of said rod engaging members;
25 each of said engaging members further defining a thru-hole for receiving one of said wedge members, each of said thru-holes aligned so that when one of said wedge members is advanced through said thru-hole said bearing surface will bear on a
30 corresponding longitudinal member to force the longitudinal member into contact with the fixation surface and engage the longitudinal member to said connector.

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20. The connector of claim 19 wherein said fixation surface is a circular concavity.

21. The connector of claim 20 wherein said longitudinal members are circular and said fixation surface has a smaller
5 radius than a radius of said longitudinal members.

22. The connector of claim 19 wherein said thru-hole of each of said engaging members are disposed laterally on the connector.

23. The connector of claim 19 wherein said thru-hole of
10 each of said engaging members are disposed medially on the connector.

24. The system of claim 19 wherein each of said wedge members are set screws.

25. The connector of claim 24 wherein each of said set
15 screws define an internal hex for receiving a driving tool.

26. The connector of claim 24 wherein the bearing surface of each of said set screws is curved to conform to a surface of each of said longitudinal members.

27. The connector of claim 26 wherein said surface on
20 said longitudinal members is circular.

28. The connector of claim 26 wherein said bearing surface is a tapered tip on said set screw.

29. A device for linking adjacent longitudinal members

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engaged to a spine, comprising:

a first engaging member, said first engaging member defining a fixation portion at a first end and a first connecting portion at a second end;

5 a second engaging member, said second engaging member defining a fixation portion at a first end and a second connecting portion at a second end;

10 a bridge member, said bridge member engageable to each of said engaging members at said connecting portions; and

each of said fixation portions further including;

15 a receptacle defined by a wall of the fixation portion, said receptacle accepting a longitudinal member when the device is disposed over the adjacent longitudinal members,

a fixation surface adjacent to said receptacle and configured for engaging a longitudinal member thereon, and

20 a first thru-hole defined in said wall of said engaging portion adjacent to said receptacle and opposite said fixation surface for receiving a wedge member, said first thru-hole intersecting said receptacle and aligned at an angle such that as the wedge member is advanced through said first
25 thru-hole the wedge member will bear against a longitudinal member in said receptacle and push the longitudinal member against said fixation surface to engage the device to the longitudinal member, whereby adjacent longitudinal members in the
30 engaging portion at each end of said bridge member are retained in a desired spatial relationship.

30. The device of claim 29 wherein the bridge member

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further comprises:

a pair of bores each for receiving a corresponding one of said connecting portions of said engaging members;

5 a pair of engaging surfaces each adjacent to and contiguous with a respective one of said pair of bores for engaging said connecting portions; and

10 a second thru-hole defined in said bridge member for receiving a wedge member, said second thru-hole intersecting each of said pair of bores and aligned at an angle relative to each of said pair of engaging surfaces such that as the wedge member is advanced through said thru-hole the wedge member will bear against said connecting portions and push each of said connecting portions against a corresponding one of said engaging surface.

15

31. The device of claim 30 wherein each said engaging surface is a circular concavity.

32. The device of claim 31 wherein the concavity of said engaging surface has a smaller radius than a radius of each of said bores.

20

33. The connector of claim 31 wherein each of said concavities and bores have a centroid; and

25 a first line between said centroids of one of said concavities and said centroid of a corresponding adjacent bore and a second line between said centroid of the other of said concavities and said centroid of the corresponding adjacent bore each diverge away from said second thru-hole such that as the wedge member is advanced through said second thru-hole said connecting portions are pushed away from an axis of said second thru-hole.

30

34. The connector of claim 30 wherein said fixation surface is a circular concavity.

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35. The connector of claim 34 wherein said fixation surface has a smaller radius than a radius of the longitudinal member.

5 36. The connector of claim 30 wherein said first thru-hole of each of said engaging members are disposed laterally on the connector.

37. The connector of claim 30 wherein said first thru-hole of each of said engaging members are disposed medially on the connector.

10 38. The device of claim 29, wherein:
said bridge member defines a slot and a first fastener bore having an axis intersecting said slot for receiving a fastener; and
15 said second connecting portion being insertable in said slot and defining a second fastener bore, said second fastener bore alignable with said first fastener bore when said second connecting portion is inserted in said slot.

20 39. The connector of claim 38, further comprising:
a fastener extendable through each of said first and second fastener bores and engageable therebetween to clamp said second connecting portion to said bridge member..

25 40. The connector of claim 38 wherein said bridge member includes a number of first fastener bores and said second connecting portion is slidable within said slot so said second fastener bore is alignable with each of said number of first fastener bores.

-25-

41. The connector of claim 38 wherein said fixation surface is a circular concavity.

42. The connector of claim 41 wherein said fixation surface has a smaller radius than a radius of the
5 longitudinal member.

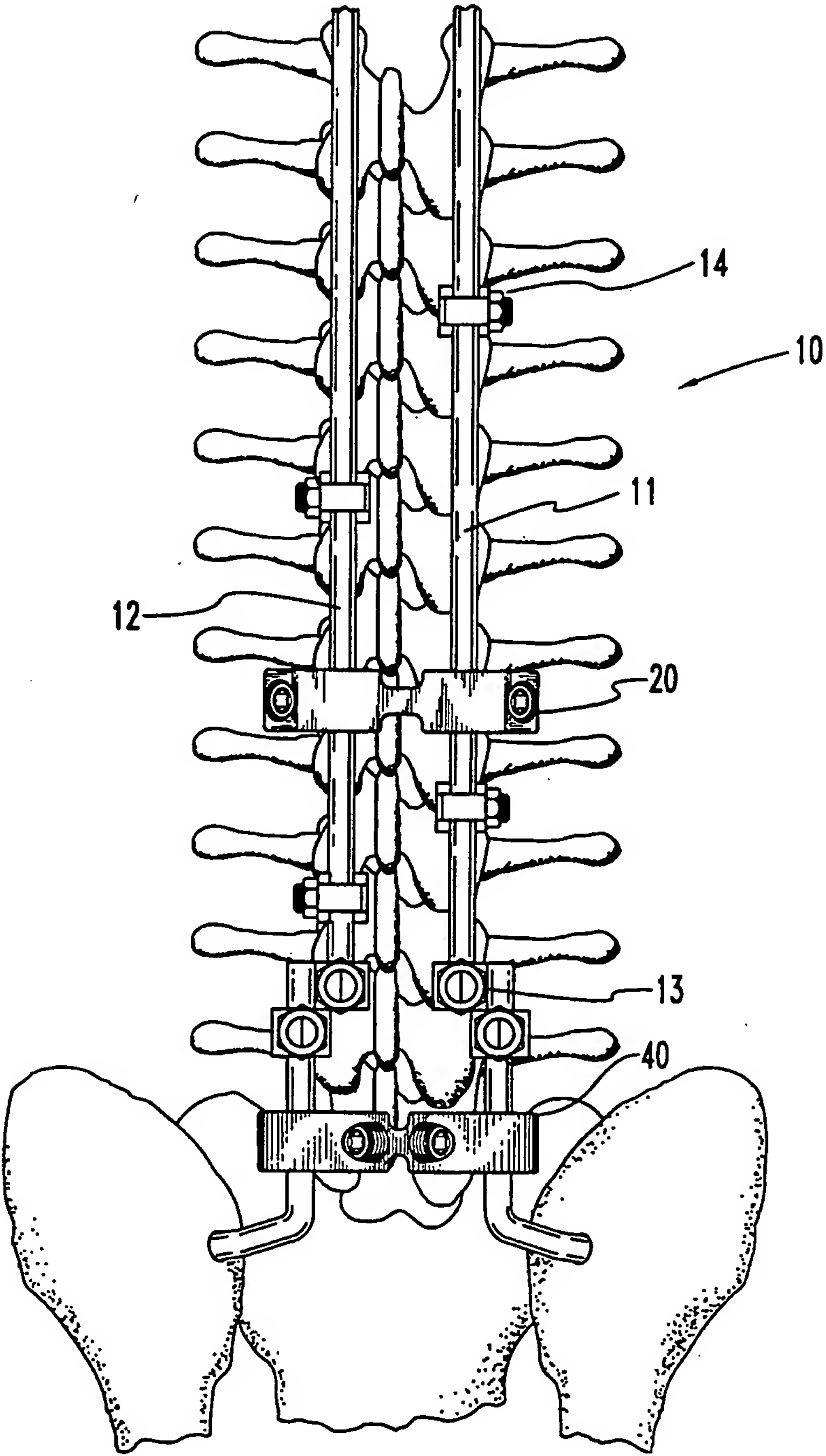


Fig. 1

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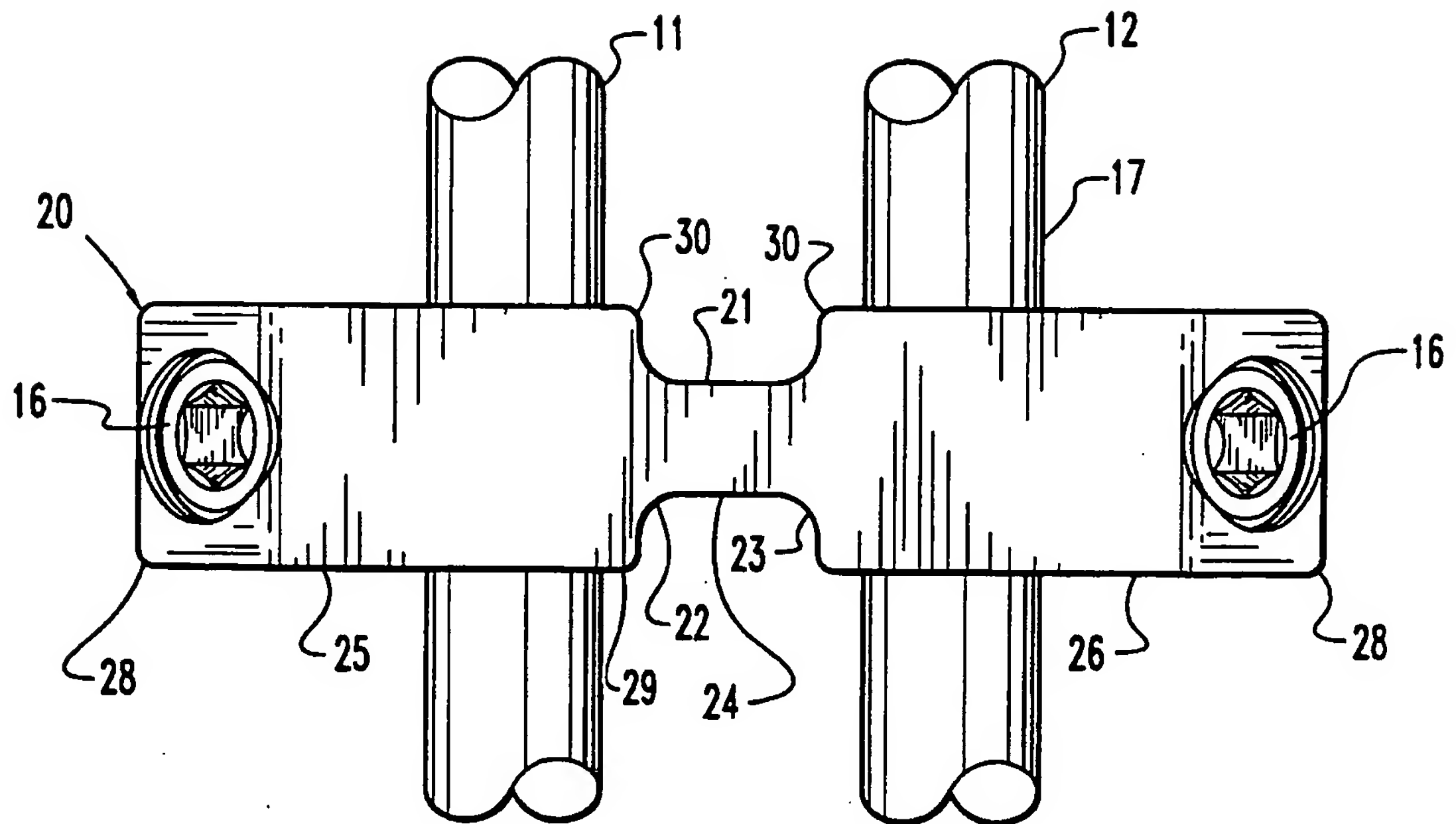


Fig. 2

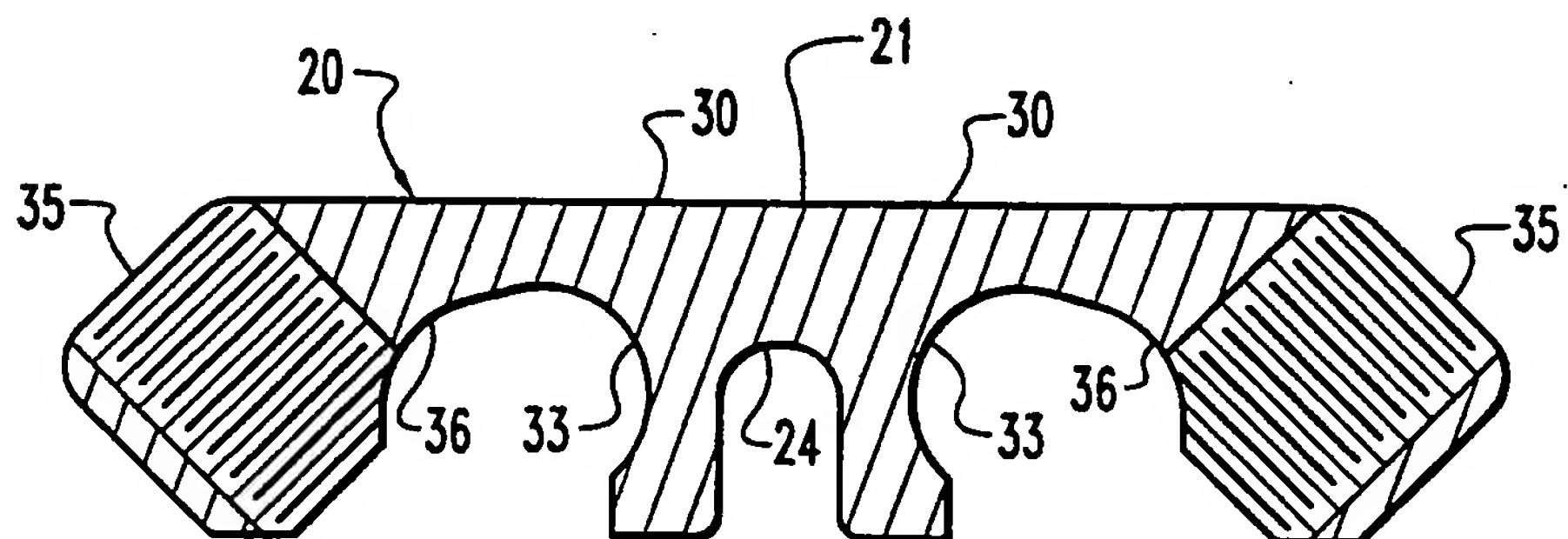


Fig. 3

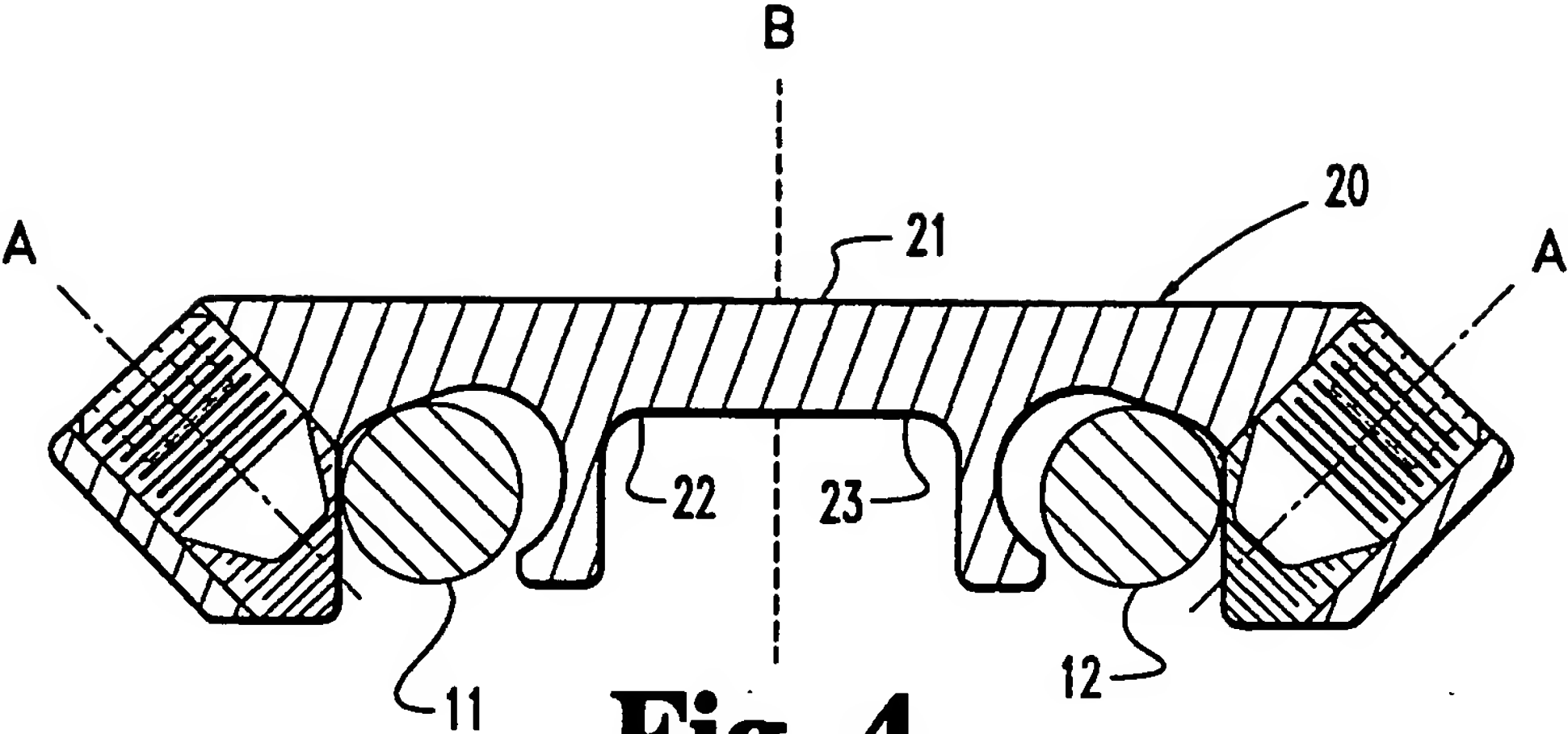


Fig. 4

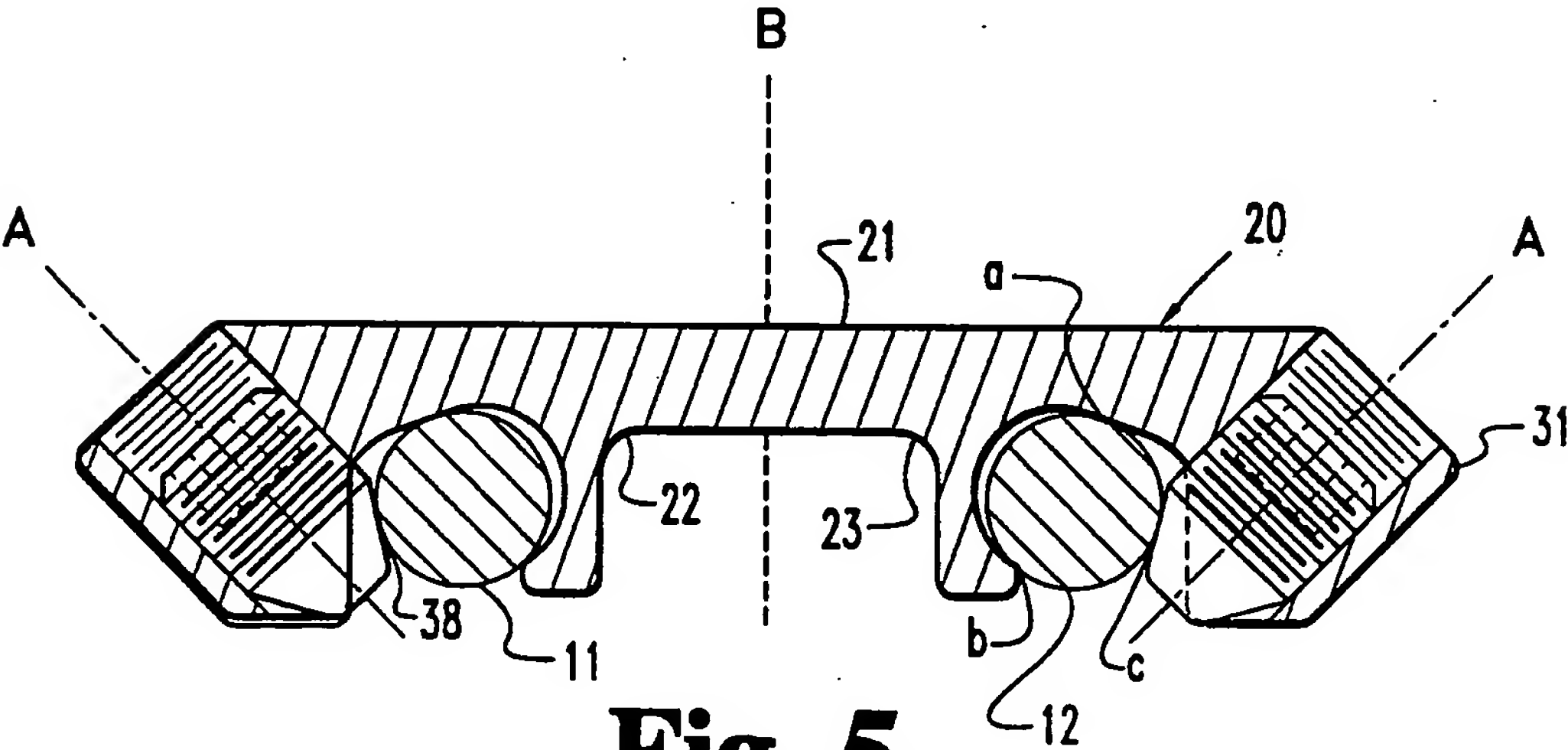


Fig. 5

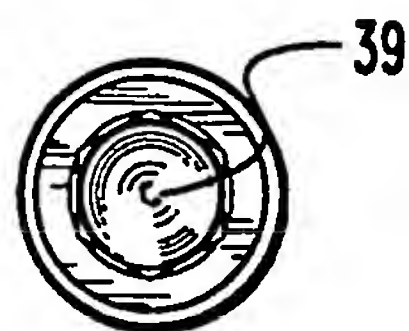


Fig. 7

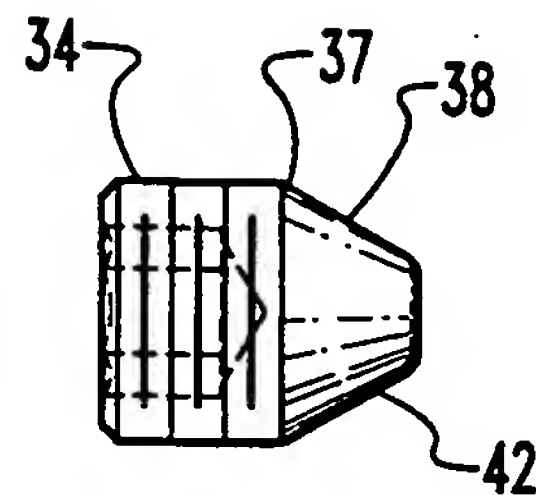


Fig. 6

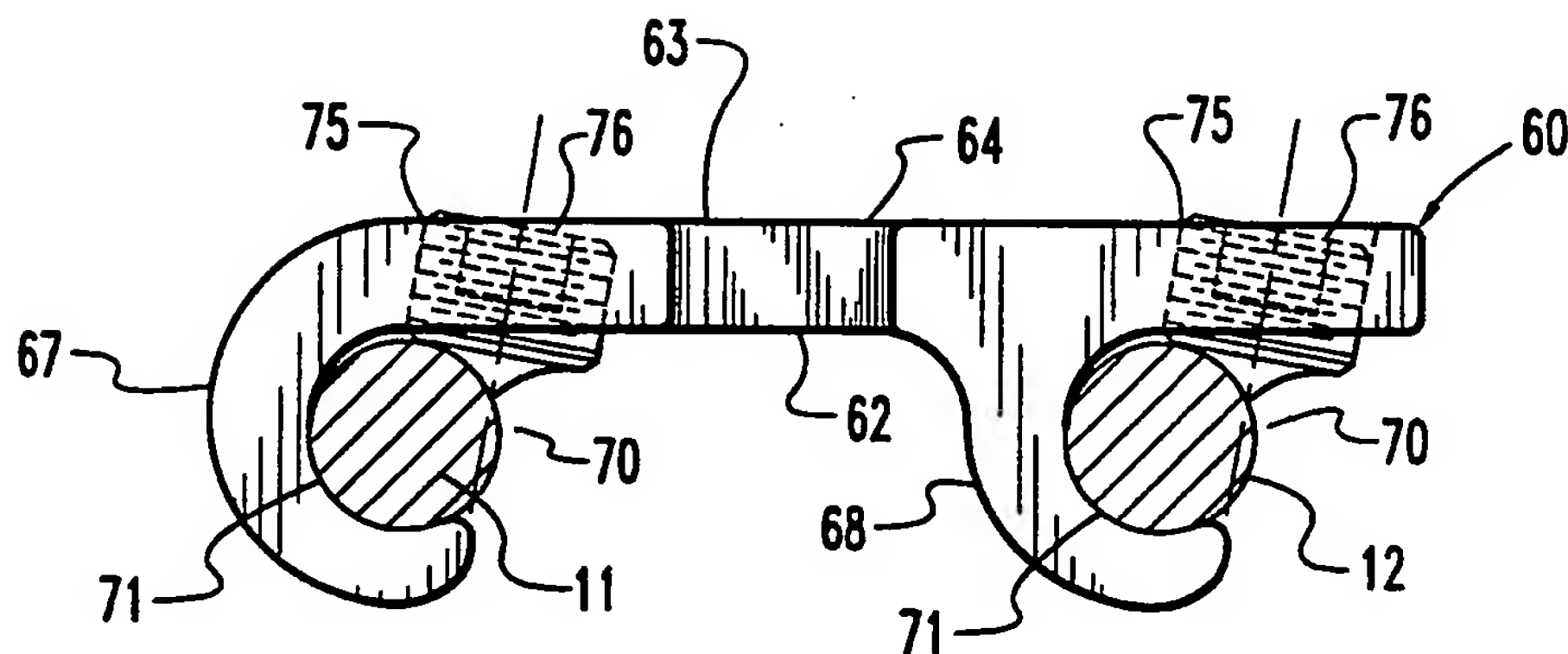


Fig. 10

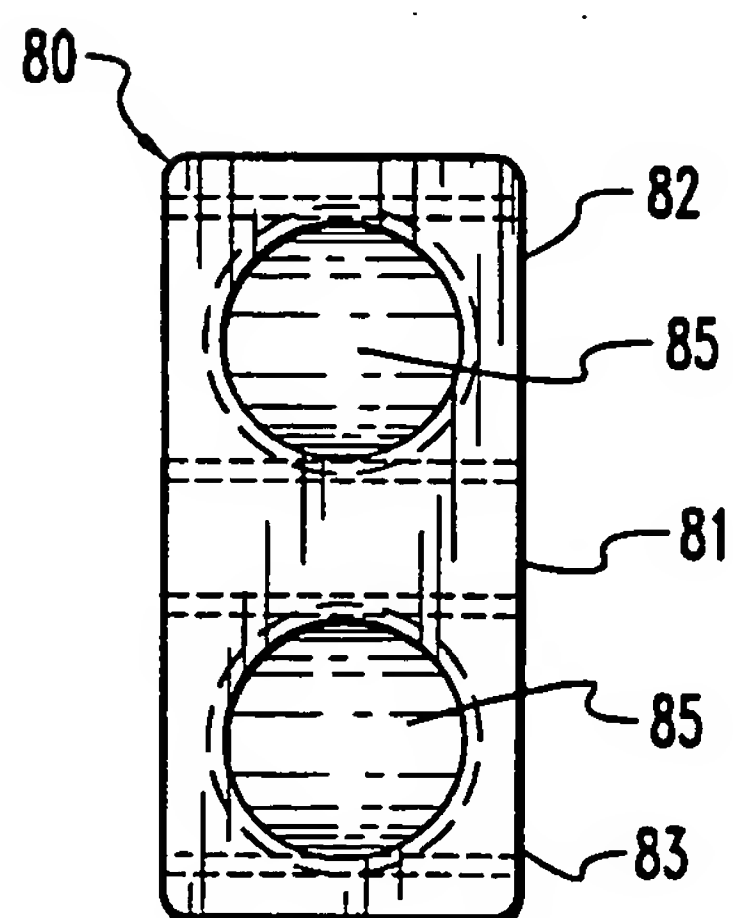


Fig. 11

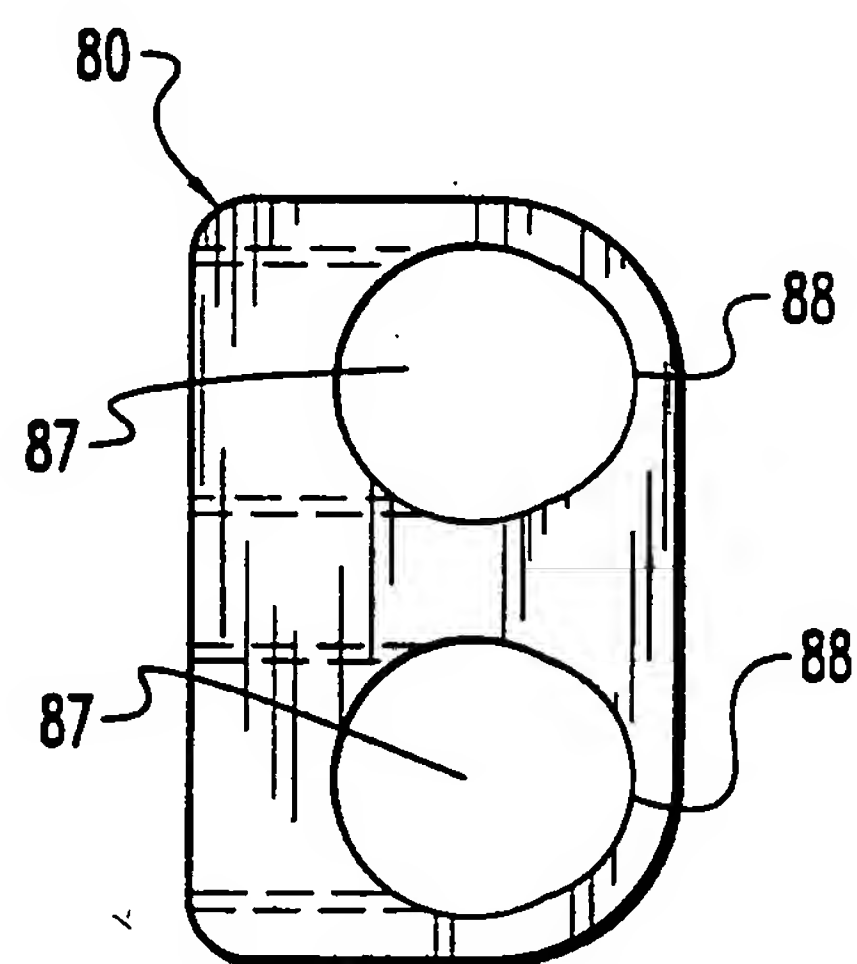


Fig. 12

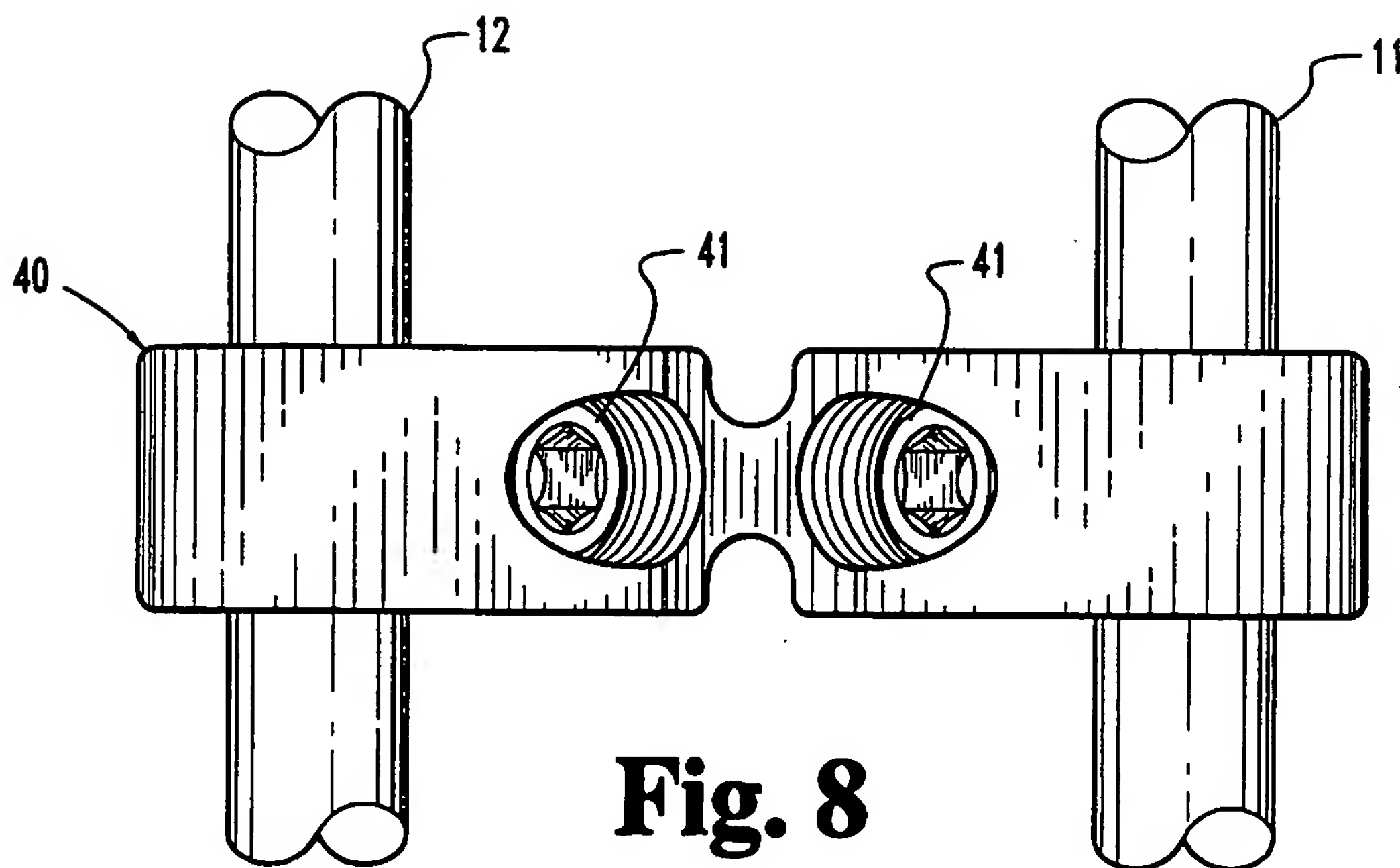


Fig. 8

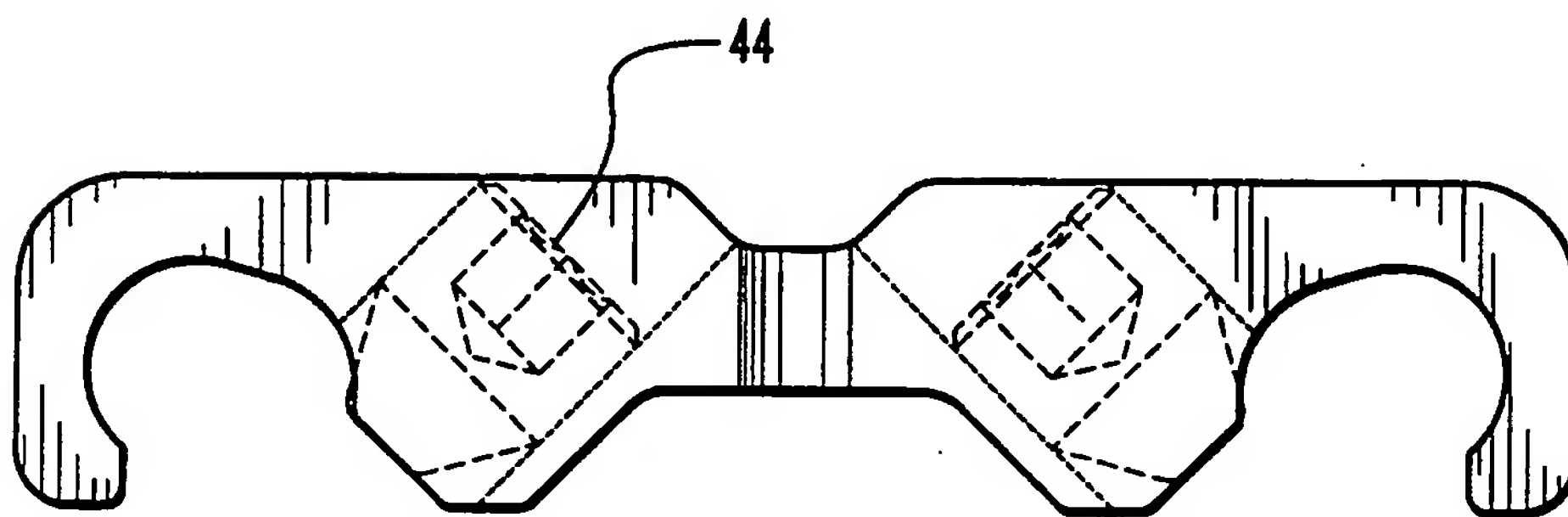
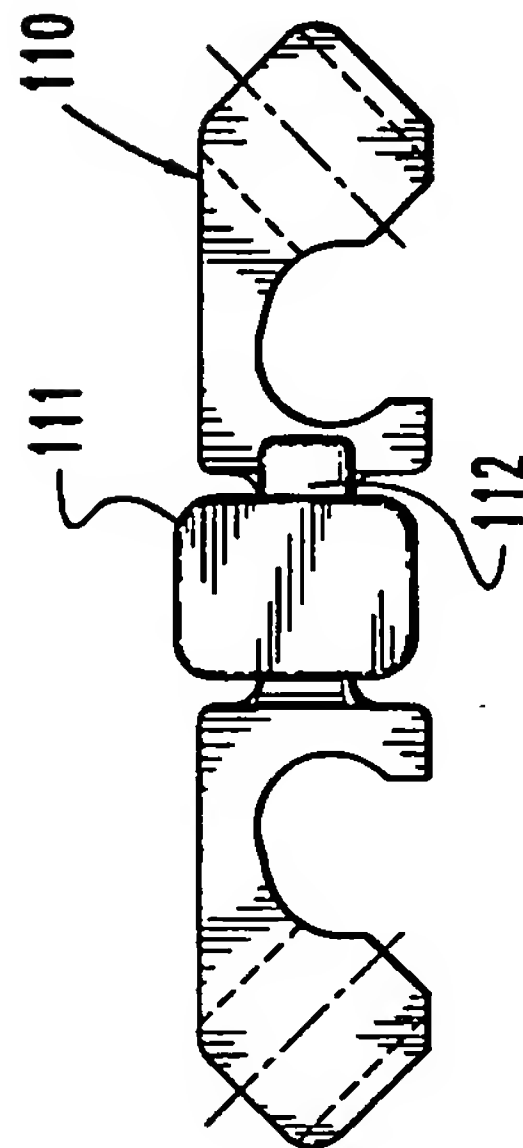
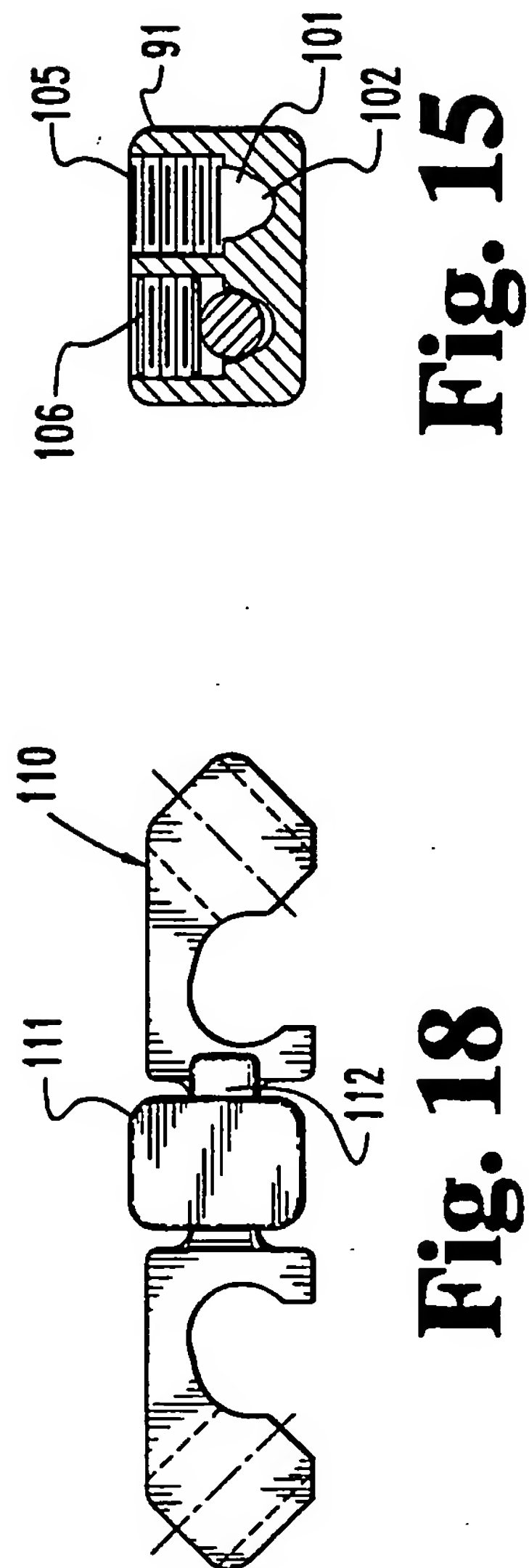
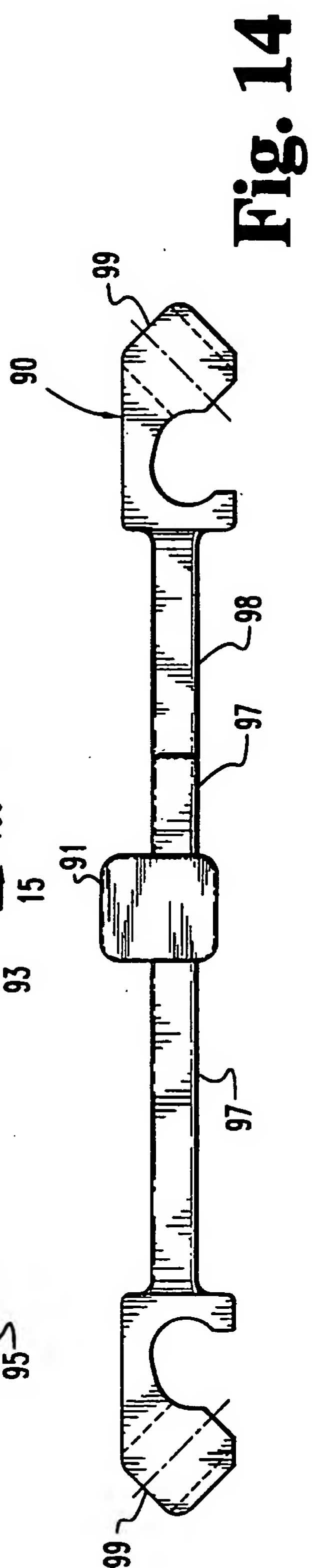
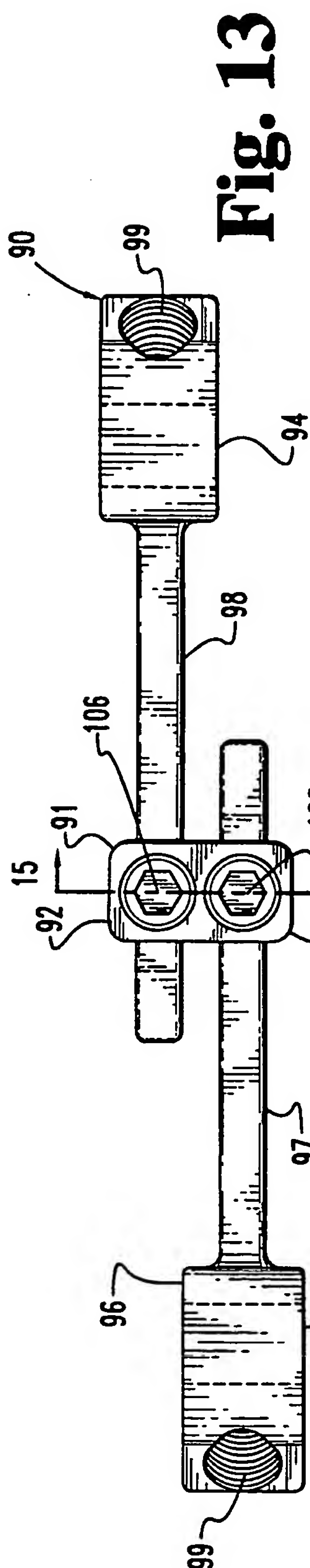


Fig. 9



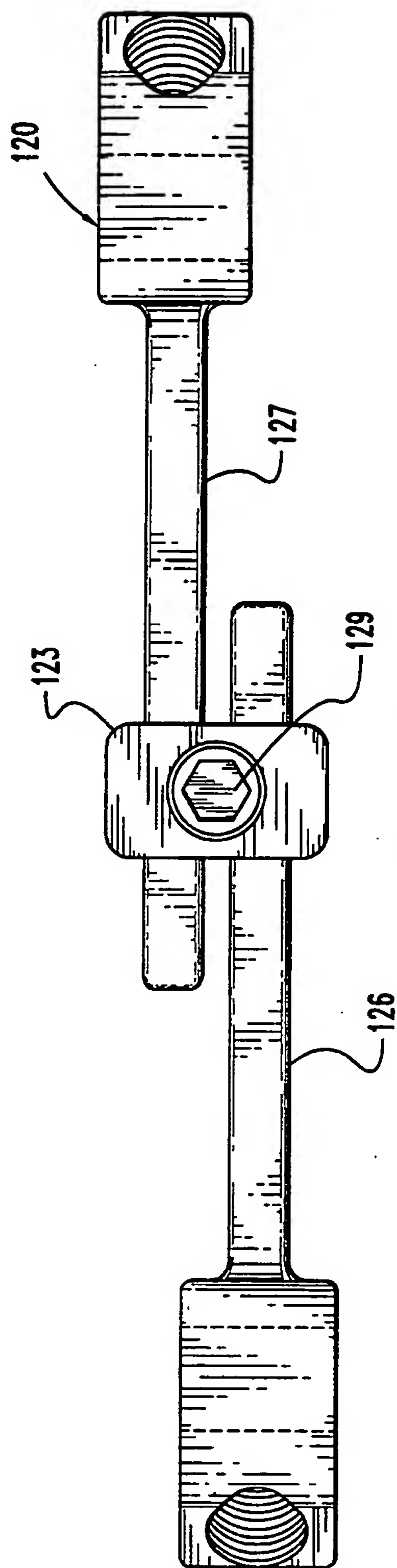


Fig. 16

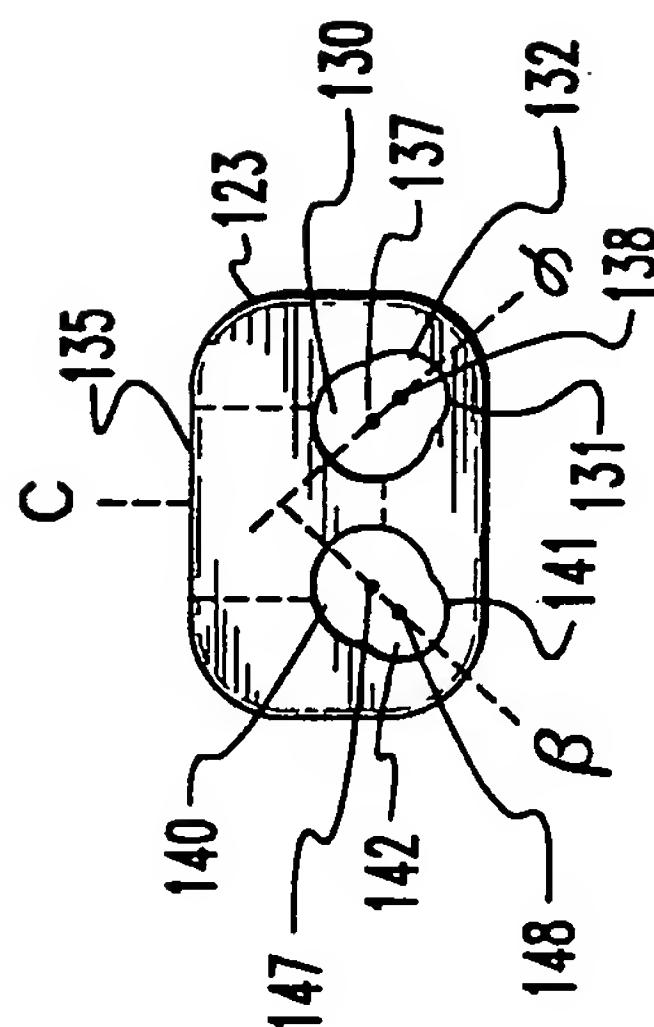
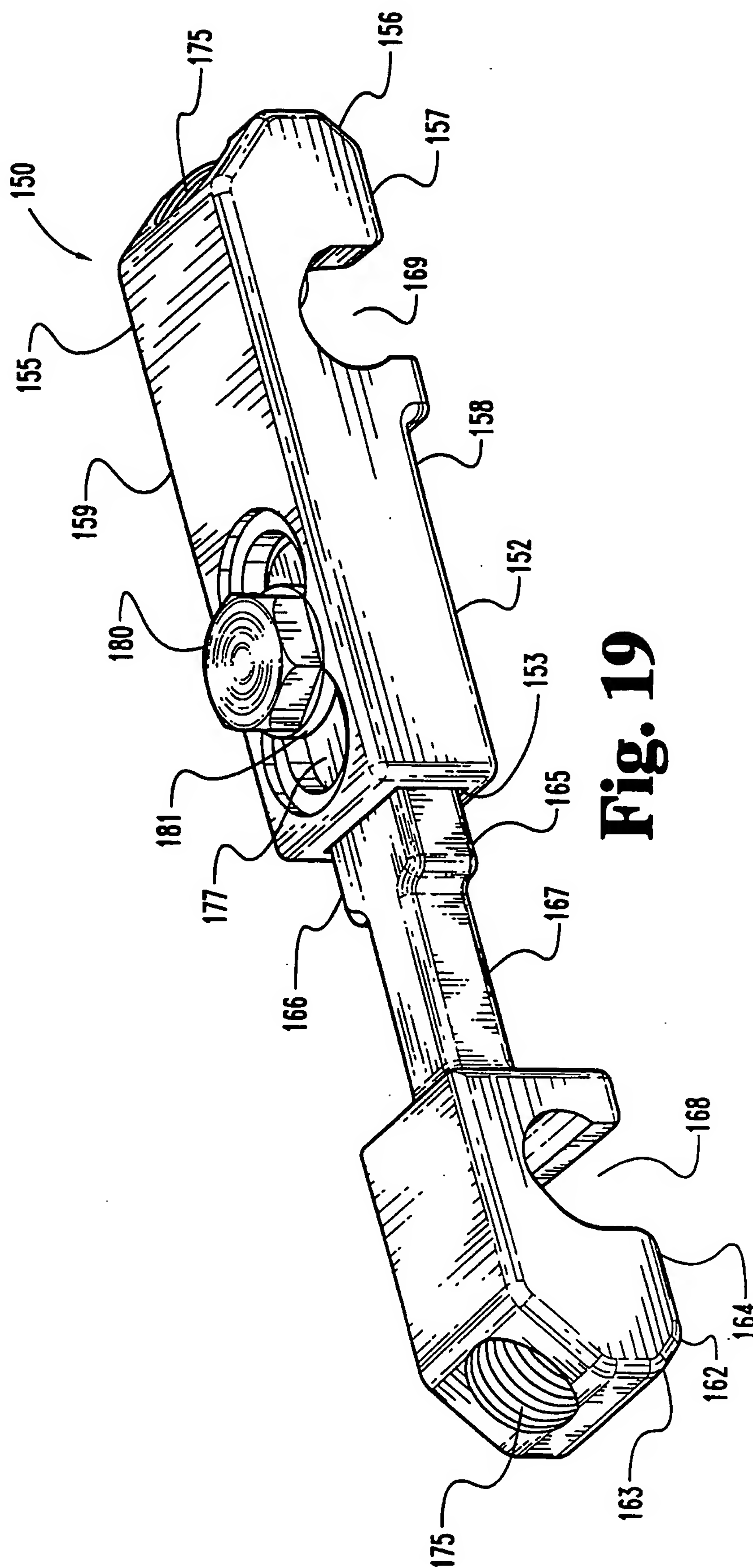


Fig. 17



Fin 19

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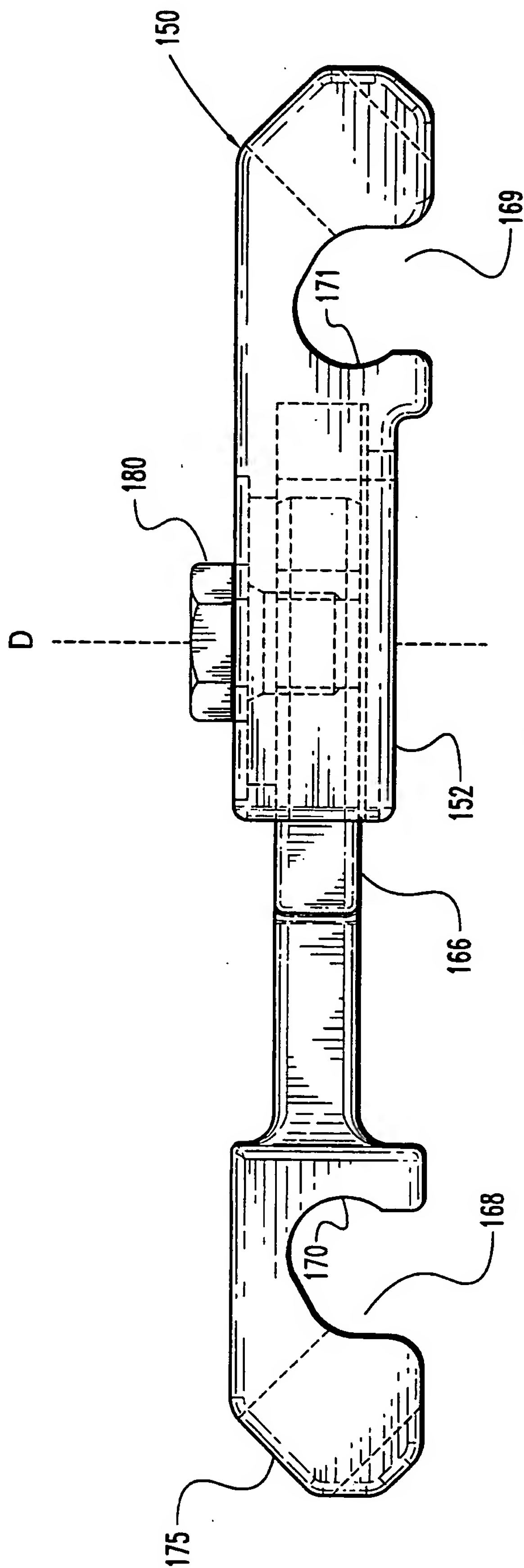


Fig. 20

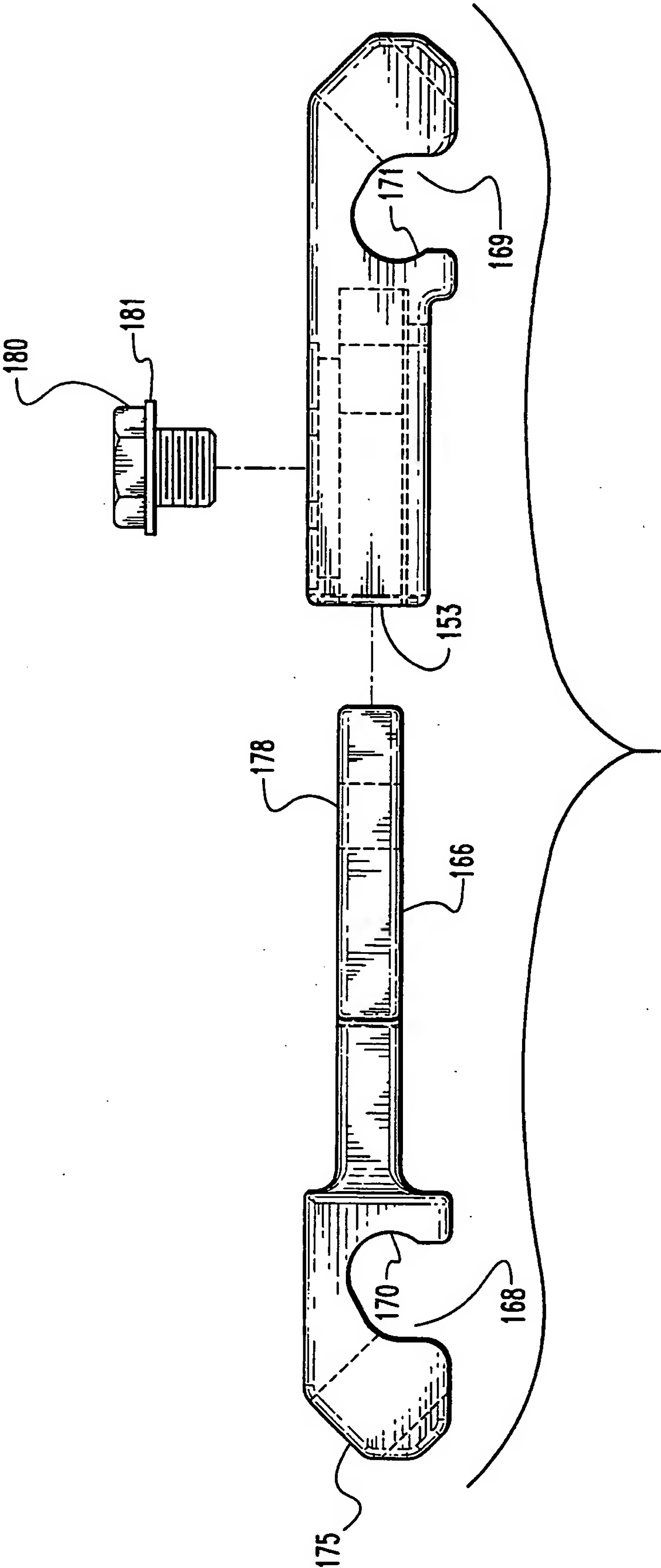


Fig. 21

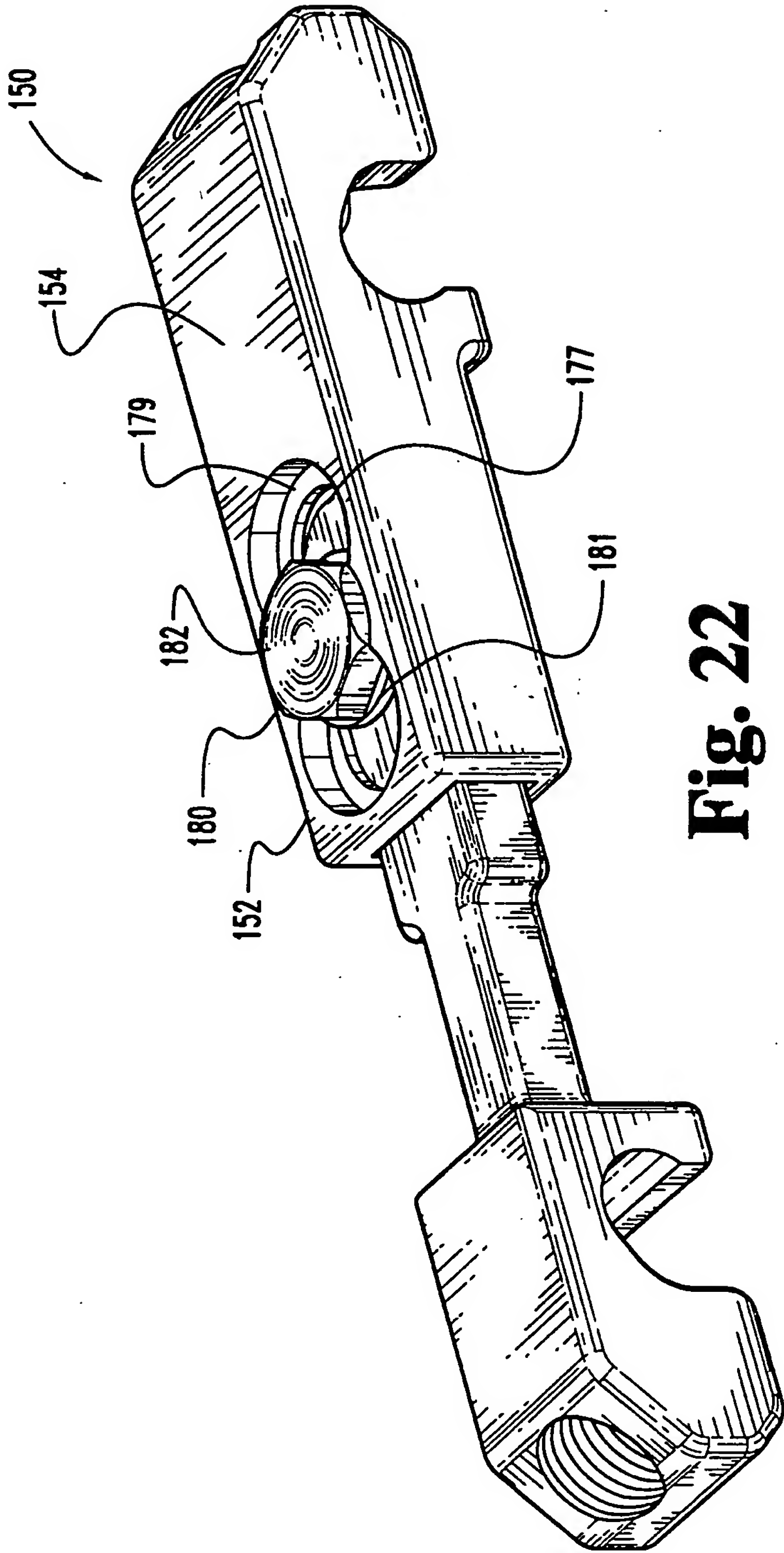


Fig. 22

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/07783

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61B 17/70

US CL :606/61

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 606/54, 59-61, 72, 73

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONEElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US, A, 5,147,360 (DUBOUSSET) 15 September 1992, see Fig. 6.	1-5, 10, 19, 20, 22-24, 29 ----- 16- 18, 21, 25-28, 38-42
X	US, A, 5,181,917 (ROGOZINSKI) 26 January 1993, see Fig. 2.	1, 19, 29
Y	US, A, 5,368,594 (MARTIN ET AL.) 29 November 1994, see Fig. 2.	16-18, 38-42
X, E	US, A, 5,522,816 (DINELLO ET AL.) 04 June 1996, see Fig. 2.	1, 19, 29

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	*T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A		document defining the general state of the art which is not considered to be part of particular relevance
*E	*X	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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*P	*Z	document published prior to the international filing date but later than the priority date claimed
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Date of the actual completion of the international search

19 AUGUST 1996

Date of mailing of the international search report

04 SEP 1996

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3590

Authorized officer

GUY TUCKER

Telephone No. (703) 308-3271